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"Let no mean hope your souls enslave;
Be independent, generous, brave;
Your father such example gave,
And such revere:
But be admonished by his grave,
And think and fear!"

Art. III. — *Survey of the Coast.*

1. *Papers on various Subjects connected with the Survey of the Coast of the United States.* By F. R. Hassler. *Communicated 3d March,* 1820. *Transactions of the American Philosophical Society.* Vol. 2. New Series. Philadelphia. 1825.
2. *Principal Documents relating to the Survey of the Coast of the United States since* 1816. Published by F. R. Hassler, Superintendent of the Survey. New-York. 1834.

It may naturally excite some surprise, that in an age peculiarly characterized by an adventurous philosophy, when scarcely any plausible scheme fails for lack of patronage, so little attention should be given to an undertaking of so great public concern, and so far as its execution has proceeded, so honorable to the nation, as the Survey of the Coast. It is, indeed, perhaps not so much as generally known, that such a survey was originated nearly thirty years since; that it has, with different degrees of success, always under the patronage of the government, and, with the exception of about fourteen years, always under the same superintendent, subsisted to the present day; and that its results, so far as they have transpired, have elicited commendation in every country but our own.

That it has been so, may be partly owing to a cause which we would do our part towards removing. The notice of a national work of this kind in the annual communication from the chief of a department, passes as a thing of course. A critique on the management of its details, in a periodical, which is exclusively scientific, is read only by the initiated; while the mass and influential part of the community may remain ignorant of a work, than which few have stronger claims to their favorable consideration. We propose to treat briefly of the enterprise in question, in such form as may suit a journal designed for more general circulation, presenting only so much of its history as may serve to shew the probable chain of policy, by which the government have been influenced in its adoption and prosecution to the present period; and so much of its technicality and detail as may exhibit its relation to other scientific works of the same age.

In doing this we refer to the works named at the head of this paper, only as giving the most authentic history of the survey, and not for the purpose of reviewing their merits as literary productions. Most of these papers can indeed never, for such a purpose, be properly made the subject of any review. With the exception of the answer to Mr. Gallatin's circular, which contains the first detailed plan for a general survey of the coast, written in unexceptionable French, they are the descriptions and correspondence of a foreigner evidently of high attainments, but composing in a language with which he is not sufficiently familiar, and occupying, so far, a situation in which few of the most talented of the world have shown themselves to advantage. So far, therefore, as the style of these papers deserve mere literary censure, it should be most leniently bestowed. We could not justify ourselves for criticising, even in a passing notice, the literary execution of a writer evidently understanding an abstruse subject fully, writing too, for the most part, in his own defence, but writing in a language with which he is evidently too little acquainted to use it with precision.

The survey seems to have been first publicly spoken of during the year 1806, and to have had for its first patrons Professor Patterson and Mr. Clay of Philadelphia, and Mr. Garnet of New Brunswick. From the account given, in page 53 of the documents, we should be inclined to consider Mr. Patterson as the originator of the project and its most zealous and efficient supporter; and that he had succeeded, perhaps through the agency of Mr. Clay, in recommending it to the consideration of Mr. Jefferson and his cabinet. There are, unfortunately, no documents preserved of that period, which explain either in what view the survey had been recommended to the notice of Mr. Jefferson, or from what motive it had been entertained and encouraged by his confidential advisers. He perhaps patronized it from the love of science, which was a predominant trait in his character, and estimated it for its general uses, as tending to the cultivation of the exact sciences in this country. They, perhaps, only appreciated it as supplying a *desideratum* in geographical knowledge, which was then beginning to be felt by the maritime interests of the country. Or it may be that both President and Cabinet considered it as an indispensable prerequisite to the system of gun-boat marine, which is still remembered as a favorite project of Mr. Jefferson. Whether the latter conjecture be specifically correct or not, yet, if the government have, from the commencement, patronised the survey rather for some object of immediate utility, than for any more general effect, which the enlarged patronage thus afforded to science might ultimately produce, we have at least one reason why so little should be known or said of the work, and why its importance should be underrated, even though its patronage may not appear to have been stinted. An accurate survey of the coast, as affording us a knowledge of the facilities and dangers of our extensive sea-board, is unquestionably of great importance to all the maritime interests of the country, and its execution a legitimate function of the general government. But as to the *manner* of its execution there are considerations of national honor, which an enlightened administration should regard as equivalent if not paramount to the more immediate object. It should not only be executed with a view to the specific interest which it is intended to subserve, but also with the best aid which the science of the time can afford; presenting thus to the government an opportunity of grafting on knowledge at home the improvements of foreign countries, and ensuring that we shall never be ashamed of our own scientific productions, even when compared with those of older nations. Since Geodetic operations have been in progress in the old world, every one of the ancillary arts and sciences has advanced rapidly. Optics and horology had, previous to 1780, been considered only as subservient to the higher astronomy, and had of course very limited encouragement; but since the commencement of the extensive surveys authorized by almost every government in Christendom, these two arts have reached such perfection as to leave scarce any thing unknown either in their theory or its application. The trigonometrical survey of England had been commenced in 1792. The survey of the coast of the United States, as we have said before, was projected in 1806, only fourteen years after. On a comparison of the first results of the British Survey, as managed by General Roy, with those of the American Survey, as devised by Professor Hassler, it will be evident that the advantage, both in science and practical skill, was on our side. The results of the British triangulation were found so defective as to make necessary not only a re-measurement of their bases, but of many of the angles connecting them. But on our side, as we shall have occasion to show hereafter, the very first determinations of 1817 have an agreement with those made subsequently in 1834, than which we have nothing better in the detail of similar operations elsewhere.

The conjecture, that the survey of the coast originated as a necessary auxiliary to Mr. Jefferson's system of defending the sea-board, by a flotilla of small armed vessels, has nothing certain for its basis, and can merely be considered as probable from the circumstance of the two projects coming before the public about the same time. It seems, however, almost indispensable to the judicious management of such a force of gun-boats, that the smaller and less practicable channels should be accurately known; as enabling these small vessels to manœuvre and rendezvous in force, by routes which would be insufficient for vessels of heavier draft.

Apart from considerations of national honor and interest, there are other reasons why a survey of the coast of the United States, if made at all, should be executed with all the precision which can possibly be obtained at any time. The coast for five sixths of its length is low, and may be considered as half formed; the beaches and shoals of which it is composed are constantly shifting by the operation of winds, and tides, and currents; so that the deep channel of one year may be a down the next. This is the case in every part of the coast, from Rhode-Island to the mouths of the Mississippi. That part of hydrodynamics, therefore, which treats of the formation of alluvions, and of the operation of surf and winds upon them, will soon become a useful and necessary study in this country. The time is not far distant when the great metropolis of New York may find the helping hand of science necessary to clear out the access to her beautiful bay. As preliminary to any project of this sort, hydrographic surveys of the most accurate kind, shewing the changes operated upon the shoals and channels from year to year, would be invaluable. Careless examinations would necessarily be injurious, as serving for false bases. And, in a general point of view, the formation of both beaches and downs is a study of much interest, and to which heretofore but little systematic attention has been given.

To return, however, to the history of the survey. The first official paper relating to it is the circular of Mr. Gallatin, then Secretary of the Treasury, dated March 25, 1807. It may be considered as an exhibit very nearly of the views of the administration, and contains throughout probable evidence that it was for some object of immediate utility, that the survey had been authorized. It may at that time have begun to be known that the French and English governments were in possession of better surveys, and more accurate soundings of our most used harbors than we possessed ourselves, and a mere feeling of shame of our ignorance, and the inferiority which we must necessarily suffer from, in case of hostilities, may have directed the attention of the government more strongly to the subject.

Mr. Gallatin says in his Paper,

> "It seems to me that the work should consist of three distinct parts, viz.
>
> "1. The ascertainment, by a series of astronomical observations, of the true position of a few remarkable points on the coast." [The reference to light-houses shows that a rapid execution was intended.]
>
> "2. A trigonometrical survey of the coast between these points, of which the position shall have been astronomically ascertained.
>
> "3. A nautical survey of the shoals and soundings of the coast, of which the trigonometrical survey of the coast itself, and the ascertained position of the light-houses and other distinguishable objects shall be the bases."

Mr. Gallatin's circular was addressed, as we learn, from another part of the documents, to the principal scientific gentlemen then in the United States. They appear to have been eleven or twelve in number, though their names are in no place mentioned. We have only in reply the letter of Professor Hassler, and cannot therefore judge, whether other projects may have been recommended by those whose opinions had been solicited by the government, or what amount of practical knowledge on such subjects was then to be found in the country.

The reply of Professor Hassler describes two modes, the first indicating a geodetic survey of the first class; and the second, the project nearly as it seems to have been understood by the Secretary.

> " La marche que vous avez tracée à cet ouvrage dans votre lettre est très juste, et en contient les veritables principes; permettez moi de les étendre seulement, en y appliquant quelques considérations plus détaillées.
>
> " Pour faire cette levée avec toute l'exactitude possible, la marche à suivre seroit la suivante. De mesurer par toute l'étendue des côtes avec un cercle répétiteur à deux lunettes, d'un pied de diamètre (ou à son défaut avec un theodolite Anglois de même diamètre au moins, et susceptible de multiplier les angles) une chaîne de triangles d'environ 60 à 100 mille pieds de côte, fondée sur deux ou plusieurs bases mesurées avec les moyens d'exactitude connus."

After describing the manner in which the topographical details shall be executed, he proceeds.

> " Si un tel plan d'opération était regardé comme d'une exécution trop entravée par les localités, il faudrait y substituer le suivant, qui serait.
>
> " De suppléer le mesure triangulaire par les déterminations de longitude et latitude, avec des chronomètres et des sextants ou cercles de reflexion, qui doivent dans ces casêtre de première qualité, et les chronomètres toujours. Une série de points et signaux systêmatiquement placés et distribués doivent par là être déterminés, de même que les triangles de la méthode precedente. Cette méthode quoiqu' elle ne soit pas susceptible de toute l'exactitude de la précédente, est cependant exempte du défaut d'accumulation d'erreurs, parceque les déterminations sont indépendantes les unes des autres. (on peut estimer les latitudes à 10'' de degré et les longitudes par chronomètres à 2'' de temps exact."

These extracts, taken in connexion, convey at least presumptive evidence, that the government were undertaking an operation, of whose extent and importance they had an inadequate conception, and that the person in whose opinion they had confided, had early conceived the idea of making its execution, if possible, not only creditable to the country but to himself. If such were the case, and the government from the commencement patronized the work only as necessary, cheap and useful, while the superintendent has been constantly aiming to give it all the aid of the most improved state of science, there has been abundant reason for the parties, by misunderstanding each other, to embroil all the details, and produce a chaos from the very best materials.

The law authorizing the survey had been passed in February of 1807. The circular of Mr. Gallatin is dated in March, and the reply of Professor Hassler in the April following. During the autumn of the same year, Professor Hassler received an official notification of the approval of his plan of the survey by the President, and was requested to communicate a description of the necessary instruments and an estimate of their expense. He subsequently, viz., in September of the same year, accepted the commission proposed to him to go to London, for the purpose of procuring the apparatus which he had indicated. The distracted state of our commercial affairs put a stop to any further measures till 1811, when the mission for the purchase of instruments was officially proposed by Mr. Gallatin and accepted by the Professor, and on the 29th of August he embarked for Liverpool. This mission was completed on the 14th of December, 1815, by the delivery of the instruments, books, and apparatus purchased for the government, to Robert Patterson, Esq. the Director of the Mint.

During the interval between Professor Hassler's appointment to go to London, viz. in May, 1811, and his return to the United States, in 1815, an interval of four years, much discontent appears to have been manifested on the part of the government with what seemed to them to have been unnecessary delay. This does not appear distinctly in the documents; but drafts for funds were allowed to be protested in London, and other indications were given that the mission was thought to have lasted long enough, conveying pretty conclusive evidence that the heads of departments had an idea that such instruments as were needed for the survey might be manufactured in a few months at most; shipped with as much care as a cargo of hard ware; crammed into the hold of a five hundred ton ship; tilted on a dray to the custom-house, and the cases hammered opened for its enlightened inspection; while the risk of all these commercial manipulations would be fully covered by the insurance. Such, however, was not the opinion of their professional agent. Duplicates of instruments were ordered of a peculiar and new construction, such as are usually expected to be two years in the hands of the artist. Standards were procured properly authenticated from both France and England. And on an examination of the dates of the several operations performed in the four years' mission, an account of which covers two pages of the documents, there is found no space of time not devoted zealously to the object with which the government agent had been entrusted; the only possible source of misunderstanding being, that the government had one view of the subject and the agent another.

Besides the delay necessarily resulting from the very detailed nature of the mission, there occurred others from the hostilities then in progress between the two nations. In one instance (our information on this point is verbal) a passport was refused at the alien office in London, until after a personal application to the foreign Secretary, who is said to have granted it with the remark, " that the British government made no wars on science." The noble lord who made this remark is certainly entitled to some gratitude from us, and some admiration from his countrymen.

But, whatever impatience may have been manifested by the heads of departments, during the procurement of the instruments, it seems all to have disappeared when they were safely delivered in this country. On the 20th of July, 1816, the preliminaries having been discussed, and the rate of compensation fixed, Professor Hassler was appointed to superintend the work, and on the 27th of the same month operations were commenced in New Jersey. There appears, however, to have been no appropriation of funds for the expenses of that year, so that the whole of that season was spent simply in *reconnoïssances* made by the superintendent. In the succeeding summer, that of 1817, the survey commenced under an organization certainly sufficient in numerical strength, but, as we may have occasion to shew hereafter, defective in consistence, and was terminated in the April of 1818, by a peremptory note from Mr. Secretary Crawford, (of which we regret that no entire copy is given with the documents,) and an act of Congress transferring the survey to the Army and Navy; at least so we believe the terms of the law are understood, as it authorizes only the employment of gentlemen from these departments of the public service. The superintendent immediately repaired to Washington, transferred his journals, instruments and authority into the hands from which he had received them, and with a coldness which we can scarce sufficiently estimate, suggested to the department the mode of preserving the work which had already been done.

But the department, being ignorant on one subject, was just as ignorant on another. It had no idea that any work had been done at all. It disregarded the suggestions of the superintendent, threw the journals into one of those limbos of documents, which the functionaries of the capital, being determined to have no secrets of state, keep therefore in a manner entirely public, and thought no more of the subject. No report from Mr. Secretary Crawford ever stated to the country what had become of the survey of the coast, and he undoubtedly supposed that the affair had ended. This unfortunately for him was not the case. The coast survey papers (the book first quoted) were read before the American Philosophical Society in 1820, and published in its regular course in 1825, and from it, in the absence of any official paper on the subject, we first learned the manner in which the whole business had been managed, and what had been done in the single year, out of eleven, in which there had been any operations at all. In that year, (we refer to 1817,) with a corps just organized, two bases, one of [*]9447 metres, and the other of 7753 metres, had been preliminarily measured, and the angles of the main triangles connecting them been determined. A zone of the coast comprehending in the meridian from the Palisades to the Highlands of the Neversink, and in longitude from the Springfield mountains to Hempstead, Long Island, had been covered with a series of primary triangles in the space of ten months, and not only this, but pyrometrical experiments, destined for an accurate determination of the expansion of the standard measures procured from Europe, had been instituted and perfected; the details, and the correspondence necessary to the organization of the service, having been all managed by a single person. And yet, at the commencement of 1818, we find the Secretary of the Treasury, the chief of a department, who should be supposed to know at least something of the detail of a project entrusted to his charge, stating, in a public document, that "the little progress hitherto made in the work had caused general dissatisfaction in Congress." The little progress! Under such circumstances so much work had never been done in the same time before. — But we will not expatiate on this disagreeable

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[*] Base of 1817, measured	9447.005	7753.7018
Calculated from Base of 1834	9447.300	7753.7983
	.295	.0965

part of the subject. Let Mr. Crawford's scientific reputation have the benefit of the maxim ; " de mortuis nil," &c. And let others, dead and living, have their due praise. If the project, as conceived by the government, or, as explained by Mr. Gallatin, was first thought of only on the score of utility, as intended to put a view of the commercial advantages of the coast into the hands of the maritime interest, disregarding any ulterior advantage which might accrue to our national character for science, by the encouragement shown to the practice of *Haute Géodésie* and its auxiliaries ; yet it is to be remembered that, on the representations of Professor Hassler and probably others of the gentlemen whose opinions had been solicited in 1806, the more worthy project was adopted, and an appropriation of fifty thousand dollars for the purchase of instruments (thirty-seven thousand dollars of which only were expended,) made without scruple and without reserve. This candid departure from the limit of the original project, to one where the aim was farther removed but more honorable, reflects high honor on those who promoted it, and leaves us ground to believe that had Mr. Jefferson and his advisers been in office, the difficulty and discontinuance of 1818 would not have taken place.

The scheme of the survey therefore was disposed of for the time, having been prosecuted not quite twelve years ; for though the law of 1818 authorized further operations by officers of the Army or the Navy, and the instruments and the equipages were all on hand, no one lifted the fallen banner. — The instruments were mostly distributed among the officers at that time employed in topographical duty. The large telescopes remained at the Capital, and it is understood were principally used for teaching the Sacs, the Creeks, and Winnebagoes, who visited Washington, the principles of optical science ; while the delicate mechanism of the principal angular instruments, which had been two years in the hands of Troughton, has the credit of having been employed in demonstrating the varieties of circular motion to the Titans of the West. An astronomical clock (we believe by Hardy) was put in charge of one of the dignitaries of the Patent Office ; who, if report says true, having broken the maintaining power, kept it still going, moving the hands forward to make up the time lost in winding. The list of curious misusers might be much augmented, but the subject is offensive, and we have perhaps already said too much.

To account for the difficulty and discontinuance of 1818, we have made use of the hypothesis, that the government was aiming at one project and the superintendent at another, a state of affairs which could scarce fail to produce misunderstanding and disorder. But there were other causes which exerted a powerful and disastrous effect, and which resulted from the circumstances of the nation at that time. We had, in the first place,* no military school previous to that year, at least the regulations of the establishment at West Point, anterior to the superintendence of Colonel Thayer, (which we believe commenced either in 1817 or 1818,) were so imperfect, that even the pupils destined to fill the higher grades of the army, were but imperfectly instructed, and it was rare, therefore, to find at that time any officer under the rank of major, with the science requisite even for a third place in the survey of the coast. In addition to this cause of destitution, we had just finished a war, the effect of which upon military establishments is always to elevate men, in proportion to their capacity for command and not for talent of any other description. Yet it was from the military that the assistants in the survey of the coast were to be selected, and this for the laudable purpose of perfecting them in the science and practice necessary to make them serviceable as *ingenieurs géographes* at some future period. Though the army and navy, both of this and of other countries, have been employed in the execution of similar functions to those requisite in the survey of the coast, there are inconveniences resulting from their employment, which can only be prevented or avoided by a peculiar organization. You cannot expect men, whose sole incentive to action is rank, (for in our country there is nothing that can be called emolument attached to either branch of the service,) whose education may have disqualified them for some, and their habits for other duties, which are necessary in the execution of such a project, to forget rank and station, and commence anew in a service in which no reputation can be gained, which is available in their profession, and in which much may be lost. Fancy a lieutenant of the Navy, of forty, (we understand there are some and will certainly be more of that respectable age in our service), acquainted only with the manly and technical part of his profession, placed in an operation of this kind in subordination to a midshipman of eighteen, who has more knowledge, and, as it may well be, less manhood than himself. It is a situation not to be thought of by men of feeling and of honor, yet one that would be of frequent occurrence in such a service. The idea, that the military and naval force of the country may be used as a heterogeneous mass in such duties, is a false one, relied upon, and urged, probably, on the ground that the corps of *ingénieurs géographes* in France, and of the ordinance in England, have each been engaged in, and successfully executed operations of the same kind, without remembering that in both those nations the immense military establishment has given the chiefs of each the power of selecting for such projects from a large numerical force, without any interference either with rank or emolument. But, apart from this, the inaccuracies of the English survey committed during the first ten years of its progress, and while it was under the management of General Roy; and the appointment of Delambre and Méchain to conduct the triangulation necessary for the great Map of France, though it had been then for several years in the hands of the French Engineers, afford some evidence that military men are not of necessity peculiarly competent to the execution of such works.

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* Vide Col. Roberdeau's paper read before the Columbian Institute, page 41 of the documents.

From the termination of the survey in 1818, until the publication of the papers in the Philosophical Transactions for 1825, nothing appears to have been thought of such matters. But after the appearance of that publication, and the favorable notice taken of the work by foreign journals, the affair began to be thought of, and from that time till 1832, public opinion had changed so much, that though there were then many projects for a survey, each advocated by gentlemen of reputation, the original plan was again adopted, and the original superintendent again appointed, with the additional and necessary power of selecting his own assistants. From the recommencement of the survey in 1832 to the present time, a belt of the coast, extending from the Connecticut River to below the Neversink, has been covered with a series of secondary and tertiary triangles; detailed surveys have been made both for the topography and for soundings of considerable distance of the coast; a base, the longest that has ever been measured with any approach to similar accuracy, has been finished, and there is every indication of the future progress of the work with honor and credit to all concerned. It is true the documents show something of misunderstanding in the matter of accounts, but such difficulties are the common attendants of new branches of any service, and will only exist until the accounting departments have time to introduce the system most accordant with the nature of the work. It is indeed gratifying to our national character, that after the temporary abandonment of a work, having such legitimate claims to our consideration, public opinion should so soon and so strongly revert in its favor. But throughout the whole of the interruption which it underwent in the period between 1818 and 1832, there were individuals of high distinction, who advocated it in terms commensurate with its importance, both in the private circles of the country and at the seat of government. Among them were the present and late President, the late Minister to France, and the present Secretary of the Navy, whose department has at present the charge of the survey.

Having said so much of the history of the survey, we will now briefly describe part of the apparatus used in its execution.

The instruments brought from Europe by Mr. Hassler, in 1815, are enumerated in page 246 of the Coast Survey Papers, in forty-nine items. The principal are :

" 1. A Theodolite, by Troughton, of two feet diameter, with which the angles of the main triangle have been measured.

" 2. Two double repeating Theodolites, also by Troughton, of one foot diameter.

"3. Two double repeating Circles, of eighteen inches diameter, also by Troughton.

" 12. Two sets of apparatus for measuring Base Lines. [All these instruments are of a peculiar construction, the plan of which was made by Professor Hassler.]

" 13. An English brass Scale of eighty-two inches, by Troughton, with an arrangement for comparison.

" 14, 15 and 17. An Iron Toise, a Brass and an Iron Metre, all standarded by Lenoir.

"5 and 6, 31, 32, 33, 34. Six Achromatic Telescopes, by Troughton, Holland and Tully.

" Two Astronomical Clocks, ten Chronometers, and two Transit Instruments."

All the angular instruments, and, indeed, most of the other apparatus, were perfected under the superintendence of Mr. Hassler, and have peculiarities of construction which we have not space to describe. The double repetition in the circular instruments, is both simple and useful, and the double screws by which the horizontal adjustments are made, seem an admirable mode of combining a very delicate with a very bold motion. But the contrivance most original is the arrangement substituted for verniers, on the large Theodolite, the principal instrument for measuring terrestrial angles in the collection. The objection to the vernier is its friction on the limb, which it must touch at least on the edge, and the consequent cramping of the motion and obliteration of the graduation. To remedy this inconvenience, divers expedients have been heretofore resorted to. The Germans and French make their verniers on an inner circle sunk down to the plane of the limb, so that both present only one surface to the microscope; the objection to this construction is the friction on the limb of the instrument. The English have used two circles turning over each other, and presenting one exterior surface inclined to the plane of the instrument. This is objectionable on the same ground as the other, namely, the friction. More recently, the verniers have been raised, touching the graduation only on its outer edge, and the limb, except where it is open opposite the scale of the vernier, covered by a case of light brass. This keeps off much dust, and diminishes the friction, but the limb is less easily cleansed from any dust which may reach it. The construction used by Mr. Hassler remedies successfully all these difficulties.

To three arms projecting from the axis are fixed three compound microscopes, having their optical axes over the middle of the graduation of the limb, and their object glasses at the proper adjustment for distinct vision and absence of parallax, elevated sufficiently above the limb to allow an adequate illumination. In the conjugate foci of these microscopes is fixed a rake, or notched lamina of steel, having a perforation for its zero, by which the large divisions of the graduation, seen on the limb, are divided in the focus of the microscope; and the seconds or fractions of the second division are measured by the turns of a micrometer screw, carrying a system of wires across the division of the rake. This contrivance is simple, necessarily accurate, and perfectly original. To make the description more intelligible, suppose a microscope, magnifying twenty times, applied to the limb of an instrument, graduated to five minutes. The space representing five minutes becomes enlarged to 1° 40′, and is easily divided into thirty parts each, equal to ten seconds, by divisions always constant in the focus of the microscope, and across the last division a micrometer screw measures by its turns tenths of seconds. The contrivance appears to be perfect.

A still more original conception of Professor Hassler is exhibited in the *appareil* of the base. It would extend this paper beyond the proper limit to attempt a description of the different methods used to preserve standards, and to subject them to comparison. The first operation in the measurement of the base was to determine the ratio of the *unit* used, with the several lineal standards of Europe. This unit was made to consist of four iron bars, each of the length of a double metre, ground and rubbed on their ends in a plane perpendicular to their axes, so as to present, when joined together, a fine cut line to a microscope. The tool for cutting the bars is described on page 256. The bars had been accurately finished longitudinally in England, but were purposely left too long. They were now cut approximately to the proper length, and the ends accurately planished, after which, two butting pieces, cut from the same bar, also accurately planished, were applied to each end, so as to present a fine line to the microscope. In this way the bars and the standards brought from Europe, were successively submitted to the *comparateur* of Troughton, (described at page 255) and by trial ground down to the length of two standard metres of Paris. The detail of this process occupies from page 250 to 273, and is of much interest. The bars having their lengths thus verified are placed consecutively in a wooden box, having their ends in juxta position and their *allignement* accurately preserved. They are kept together by double steel clamps, and make therefore an unit of eight inches. The perfect contact of each with each, is determined by the line presented on each of the superficies of the bar, and is not disturbed during the manipulation necessary in measuring.

In all the former measurements of geodetic bases two, and sometimes three, units had been used; the contact between each pair being made mechanically or by touch. The objection to this is, that the very act of making the contingence, whether it be made on a point or surface, subjects the resting unit to a shock or pressure which may change its position. Aware of this objection in the measurement of the base of the *systéme métrique*, by Delambre and Méchain, a double system of measures, one of platinum and one of brass, were used, and the contacts read on verniers or graduated languelles at each end of the bars, which answered the purpose also of a metallic thermometer. By this arrangement, however ingenious, the measurement was made tedious and the reductions complicated. Nor did it answer fully the object of its distinguished inventors, as will be seen by consulting *Base du Systéme Métrique, Tome* III, page 231.

Professor Hassler essayed to make the ends of his bars determinable by an optical line, and has succeeded. The description of the contrivance used for this purpose occupies from page 274 to 286. The ends of the last bars are hollowed out in the centre of their vertical section, so that a thin film or web can be drawn across their extremity, the middle of which is the end of the measure. Over these ends in the operation of measuring a base, are placed compound microscopes, fixed on strong stands. The microscope has a double object glass, one half of which makes in the focus an image of a wire or cross, cut on ivory below, and to which the optical axis of the microscope is adjusted; and the other half makes also in the focus, an image of the film on the bar. When the microscopes are fixed at both ends, the bars are removed, and the axis of the microscopes preserves in the air the extremities of the line measured. The description of the apparatus for *allignement* and for levelling is very detailed and will be readily comprehended. In the course of the last season a base has been measured in this manner, which, when reduced to the mean temperature, is 14,058.9912 metres, or 8.7397 miles in length. This base is on the sand beach of Fire Island, and as it is for its whole length nearly on the level of the sea, may be considered as an arc of the earth's surface.

The Coast Survey papers, published in 1825, contain many other interesting details relative to geodetic works, of sundry kinds, which it would exceed our limits to notice. Among others, the mode of observing with the large circular instruments, so as to compensate for the errors both of eccentricity, of level and of collimation, will be found very interesting. The second publication also contains detailed accounts of the progress of the work, and of its present organization. The main and secondary triangulation have already extended from the Connecticut River, or near it, to near the Delaware, covering a zone of the coast, of an average breadth in land, of twenty-five miles, including all the defensible portion of the sea-board.

We are happy therefore to consider that a work, so well calculated to promote our reputation abroad and our advantage at home, has at length begun to be properly appreciated, and that, with the patronage of its distinguished friends, it is certain now to proceed steadily onward to completion. What would have been the consequence of adopting for this national object a cheaper and less accurate mode of execution, instead of prosecuting it with all the aids which the science of the present day affords? Before even the details had been commenced, a comparison of the results with those derived from similar surveys in Europe would have made us ashamed, both of ourselves and our country. The preliminary survey, like the work of Roy, in England, and of the first engineers in France, would have been set aside, and the present mode resorted to as the only one worthy of the object.

It is not, however, for its direct utility to the commercial interest and the defence of the country, that we think the present work has the greatest claim to favorable consideration; but for the general impulse which will thus be communicated to every branch of science. Among the new sciences which have arisen during the last century, there is none which has conduced to so much practical improvement in the co-ordinate sciences as that of Geodæsia. Being entirely general in its subjects, and treating only of the measure and configuration of the planet on which we live, its actual operations, from the time of Cassini to the present, have tended more to the improvement of every species of instrument used in the exact sciences, than could have been effected by any patronage, however princely or munificent. The progress of astronomy had contributed to the perfecting of the Telescope, and the large murals of the English school had shewn what could be done in measuring simple angles on fixed arcs of a large radius. But the cultivation of Astronomy was necessarily limited to royal and academic foundations, which, after the impulse given by the founder had been expended, may be considered rather as conservative of the knowledge which has been acquired, than as judicious and persevering conquerors of any new domain. The effect of the introduction of practical Geodæsia upon optical and mathematical science of every kind, was such as is produced by a patronage at once bounteous, useful and intelligent. It brought the transcendental qualities of the higher analysis, and the delicate and almost inappreciable fabrications of the mathematical artist, both of which had begun to be considered as the mere excrescences of a luxuriant philosophy, into every day use, improving in this way both the ingenuity of analysis and the skill of the scientific mechanic.

The principle of repetition in measuring angles, by which the errors of excentricity and of point are compensated or destroyed, had been commenced by Mayer as early as 1752. But it was not until after the commencement of the measures in France of the arc of the meridian; not till after the attempts had been made (finally with success) to measure, with *portable* instruments, angles, equal or approximating very nearly to the accuracy of the large and *fixed* instruments used in an observatory, that the repeating circles of the present day acquired delicate and accurate construction. The effect of the improved Geodæsia has indeed been to overthrow all the preconceived notions of accurate measurements; for, whereas, in the ordinary operation of surveying, it had been held orthodox to devote the strictest attention to the linear measures, determining as much as possible the angular elements from them; we now, on the contrary, from a single line accurately measured, and considered as constant, of which every other line in the survey becomes a function, determine every important point in a region of one hundred miles square, without an error greater than the diameter of one of the signals or objects used to observe upon. The practice of Geodæsia gave a new stimulus, which at that time was much wanted, to all the branches of art, which have been fostered by, and were auxiliary to astronomy. The Telescope and Microscope have subsequently been carried to their highest pitch of improvement, and their application to every angular instrument is now thoroughly understood. The invention of the Heliotrope; the improvements in Dividing Engines; in Horology; and even in Pyrotechny, from the necessity of using fire signals to be seen at great distances sea-ward, are all due, in great measure, to the spirit which has been infused into artists and men of science, since the commencement of the extensive geodetic surveys which have been pursued for the last half century in Europe and in Asia.

In addition to the adaptation of innumerable formulæ, to the invention of delicate and subtle mechanical contrivances, for the particular uses of Geodæsia, the two sciences of Descriptive Geometry and Topography may be considered as deriving their existence from it. The first mentioned science, as known during the last century, under the name of Perspective, was crude and imperfect; indeed, there was no treatise, in which its elements had been intelligibly discussed. On beginning to fill up the details of the extensive geodetic operations in France, it was discovered that the old and arbitrary modes of delineation were not only uncertain but erroneous, and it became necessary to return to first principles; to create a new science, by which all the configurations of solids could be accurately projected; and by which, in its application to Topography, a map became a picture; presenting, at a single glance, either to the military or civil engineer, the plains, the elevations, the streams among which he was to operate; as well as the other accidents which had at first been more peculiarly the province of Topography, namely, the roads, towns, forts, woods, and farms. So perfect has this science of Topography now become that, on a scale of $\frac{1}{10000}$, the character of the crops of the cultivated part of a region are intelligibly designated.

It has been in this light, and for such purposes, that the governments of Europe, have encouraged, munificently, similar works. France has not only been covered with a net-work of triangles, but her parallel of Brest, has been carried eastward and connected with the Russian surveys, now in charge of Professor Tralles. The kingdom of Hanover had been triangulated about twenty years since by Gauss, it being during the progress of this survey, that this distinguished mathematician invented the Heliotrope. The triangulation of Switzerland had been commenced, and part of it (we believe the Canton of Berne) finished by Professor Hassler previous to his leaving that country, in consequence of the revolutionary troubles. It has, we believe, been continued by Professor Tralles. Professor Struve has now charge of the geodetic survey of Russia. The Eastern coast of Spain has been triangulated by Biot and Arago. — The trigonometrical survey of England, under the supervision of the board of ordnance, has been completed, and that of Ireland commenced. — By a joint commission of both the English and French academies, the meridians of Greenland and Paris have been connected. The English East India Company, with a laudable spirit, have, for the last twenty years, been carrying on similar operations over a large portion of their territories. The French have, during the last year, given to the public a geodetic survey of the Morea; and nearly the whole surface of Europe and Asia is already covered with geodetic determinations, accurately and uniformly made. The distinguished atronomer Bessel has been some time employed in combining all these results, and deducing from them an accurate determination of the elements of the terrestrial spheroid: and has, in the course of the present year, communicated to his correspondent in this country the proximate results of the investigation.

Such being the state of Geodæsia in the old world, and such being its uses and effects upon science and the arts, it cannot be supposed that any consideration of false economy will again influence an administration in this country to look upon it otherwise than with favor. It is not by its immediate use, that we can most justly appreciate it, but by those more remote, though not less certain advantages, which have by similar means been produced elsewhere. It is to serve the country, by practising the young officers of the army and navy in operations requiring an intimate knowledge of the higher branches of the exact sciences; by contributing to the formation of a school of native artists, who may presently be able to furnish the requisite instruments of our own manufacture; and by bringing together into competition and acquaintance, the artists and scientific men of the country, thus forming a school of the highest and most useful talent in it. By such considerations it should be estimated both by the people and the government; for by such results it will be doubtless attended, should the patronage of the government be continued to it on a scale commensurate with the importance and dignity of the object.

ART. IV. — *Moore's Lectures on the Greek Language and Literature.*

Lectures on the Greek Language and Literature. By N. F. MOORE, LL. D. Professor of the Greek and Latin Languages in Columbia College. 12mo. New York. 1835.

PROFESSOR MOORE has long been known as an able and zealous teacher of the classics. From the academical lecture-room the reputation of his learning has noiselessly gone abroad, and he is now justly placed among the most distinguished American scholars. In 1834, he published an unpretending volume on the mineralogy of the Ancients, which is a model